

THE MINERAL INDUSTRY OF

CHILE

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The Republic of Chile is located at the southern tip of South America and borders Argentina, Bolivia, Peru, and the South Pacific Ocean. Chile has a total area of 756,950 square kilometers (U.S. Central Intelligence Agency, 2003§¹). In 2002, the country had a population of more than 15 million inhabitants and a gross domestic product (GDP) of about \$64.45 billion. The nominal GDP in current U.S. dollars fell by 3% in 2002 compared with the decrease of about 11% in 2001 (International Monetary Fund, 2003§). The real GDP increased by 2.1% in constant 1996 Chilean pesos. In 2002, the output of the service sector amounted to 56% of the GDP; industry, which included mining, 34%; and agriculture, 11% (Central Bank of Chile, 2003, p. 16, 30, 62).

In 2002, total exports were valued at \$22.3 billion. Of this total value, \$7.6 billion (34.2%) was from copper, although this value of copper exports was a decrease of 7.1% compared with that of 2001 as a result of historically low international copper prices. The value of the main noncopper exports, such as, in order of importance, fruits, wine, and fish, increased by about 3% and that of nontraditional goods decreased by 0.3% in value. Total imports were valued at \$20.7 billion. The registered trade surplus amounted to \$1.6 billion in 2002 compared with \$1.1 billion in 2001 (Central Bank of Chile, 2003, p. 34). Total foreign direct investment (FDI) inflows to Chile decreased to \$1.1 billion in 2002 from \$3.0 billion in 2001 (U.S. Embassy, Santiago, Chile 2002).

Government Policies and Programs

Chile has free trade agreements with Canada, Colombia, Costa Rica, Ecuador, Mexico, and Venezuela that provide for duty-free trade in most products. In 2002, Chile was an associate member of the Common Market of the South (MERCOSUR) (Argentina, Brazil, Paraguay and Uruguay) and has a trade liberalization agreement with Bolivia. In April 2002, Chile entered into trade agreements, one with the European Union and one with the Republic of Korea, in which both sides agreed to eliminate all import tariffs between them during the next 10 years. On December 11, 2002, the United States Trade Representative announced that the United States and Chile had successfully concluded negotiations for the U.S.-Chile Free Trade Agreement, which was signed on June 9, 2003 (U.S. Commercial Service, 2004§). This agreement, however, would still require the approval of the legislatures of both countries before actually being adopted (U.S. Energy Information Administration, 2003§).

Chilean law requires that FDI proposals be approved by the Government's Foreign Investment Committee. Since 1991, this approval has been expedited for almost all foreign investors through heavier reliance on the provisions of the 1974 Chilean foreign investment statute (Decree Law 600), which allows investors to sign standardized contracts with the Government of Chile (U.S. Commercial Service, 2001§).

Structure of the Mineral Industry

The Chilean Government, through the Ministry of Mines, exercised control of the mineral industry through three large state-owned mining companies and four regulatory agencies. The mining companies were the world's leading copper-producing company Corporación Nacional del Cobre (CODELCO), Corporación de Fomento de la Producción (CORFO), and Empresa Nacional de Minería (ENAMI). The subsidiaries of CORFO included Cía. Chilena de Electricidad S.A., Cía. de Acero del Pacífico S.A. de Inversiones, Empresa Nacional del Carbón S.A. (ENACAR), and the state-owned oil company Empresa Nacional del Petróleo S.A. (ENAP). Sociedad Química y Minera, S.A. (SQM) was formerly a subsidiary of CORFO but was privatized in 1988 (Sociedad Química y Minera, 2003§). The four regulatory agencies were the Comisión Chilena del Cobre (COCHILCO), the Comisión Nacional del Medio Ambiente (CONAMA), the Foreign Investment Committee, and the Servicio Nacional de Geología y Minería (SERNAGEOMIN).

ENAMI processed, smelted, and refined minerals for small- and medium-scale mining companies. In 2002, ENAMI controlled concentrators at Matta, Ovalle, Taltal, and Vallenar in addition to the Paipote smelter and Las Ventanas smelter and refinery. Las Ventanas smelter and refinery, which was located 8 kilometers (km) from Quinteros in Region V, had an installed smelting capacity of 400 metric tons per year (t/yr) and a refining capacity of 315 t/yr.

CODELCO had four mining divisions (Codelco Norte Division, Salvador Division, Andina Division, and El Teniente Division) and one industrial division (Talleres Division); all were located in northern and central Chile. In 2002, the Board of CODELCO approved the creation of Codelco Norte Division by the merger of the Chuquicamata and Radomiro Tomic Divisions. The new Division started operations in 2002. The Chuquicamata mining complex, which was located 1,650 km north of Santiago, Chile, in Region II at 2,870 meters (m) above sea level, had two open pit mines, Chuquicamata and Mina Sur. Ore from both mines was processed by using electrolytic refining and electrowinning methods to produce 596,000 t/yr of cathodes with a purity of 99.99% copper. It also produced some 12,800 t/yr of anodic slimes, molybdenum, and sulfuric acid. The Radomiro Tomic Mine, which was located 1,670 km north of

¹References that include a section mark (§) are found in the Internet References Cited section.

Santiago at 3,000 m above sea level, had an open pit mine from which oxide minerals were extracted; after leaching treatment, 297,000 t/yr of copper cathodes was produced (Corporación Nacional del Cobre, 2003, p. 7).

SQM was the world leader in specialty fertilizers, iodine, and lithium in 2002. These products were obtained from processing caliche ore in Regions I and II and saline brines in the Atacama Desert in Region II. The caliche was extracted from mines located in Maria Elena, Pampa Blanca, and Pedro de Valdivia and was processed to produce iodine, potassium nitrate, sodium nitrate, and sodium sulfate. The brines in the Atacama Desert contain high concentrations of boron, lithium, magnesium, potassium, and sulfate. The favorable atmospheric conditions of the Atacama Desert and the quality of the brines and caliche ore allow SQM to be one of the lowest cost producers worldwide of, in order of economic importance, potassium chloride, lithium carbonate, potassium sulfate, and boric acid (Sociedad Química y Minera, 2003, p. 13).

In 2002, the mineral industry employed 47,304 people, which included staff and office personnel who worked directly for the minerals sector. The metals sector employed about 39,809 workers; the industrial minerals sector, 5,290 miners; and the mineral fuels sector, 2,205 workers, which included 800 coal miners and 1,405 oil workers. Copper mining alone employed 34,997 workers, or about 74% of the mineral industry; this total included copper mining company workers and copper contractors' personnel. The large-scale copper mining firms employed 28,604 miners; the medium-scale firms, 3,707; and the small-scale firms, 2,686 (Servicio Nacional de Geología y Minería, 2003, p. 114).

Environment

The basis of Chilean environmental regulation is the Chilean Environmental Framework Law (Law 19,300). Adopted in 1994, it established the country's general environmental policy and regulates all major activities likely to have an environmental impact. This law created an Environmental Impact Assessment System that is implemented by CONAMA when more than one region of the country is involved or by the respective Comisión Regional de Medio Ambiente (COREMA) when only a single region is involved (Baker & McKenzie, 1997§).

Exploration

The number of official exploration claims increased to 19,615 in 2002 from 18,220 in 2001. Mining exploration claims have to be renewed every 2 years. Likewise, an accounting of exploitation claims, which was based on paid annual licensing fees recorded by SERNAGEOMIN showed that the total number of mineral exploitation claims in 2002 increased to 1,445,355 from 1,442,784 in 2001 (Servicio Nacional de Geología y Minería, 2003, p. 150-151). A 2002 survey of mining companies conducted by the Fraser Institute ranked Chile as the third most favorable region for mineral exploration out of 47 international and regional jurisdictions (Fredricksen, 2002§).

The iron ore-copper-gold (IOCG) belt in the coastal area straddling Regions III and IV in Chile appeared to receive the brunt of renewed exploration efforts in 2002. Noranda Chile Ltda. continued to conduct the exploration of El Morro prospect in Region III and increased the indicated resource to 465 million metric tons (Mt), which contained 0.61% copper and 0.50 gram per ton (g/t) gold at a 0.4% copper cut-off. El Morro was owned by Metallica Resources Inc. of Denver, Colorado. Although Noranda Chile was in good standing with respect to its agreement with Metallica Resources to earn a 70% interest in El Morro by spending \$10 million on exploration and development from 1999 to 2005, paying an additional \$10 million to Metallica in 2005, and completing a feasibility study by 2007, Noranda Chile announced in 2002 that it would suspend its exploration efforts at El Morro during 2003 (Tarbutt, 2003).

Also in Region III, Minera Atna Chile Ltda. (a subsidiary of Atna Resources Ltd. of Vancouver, British Columbia, Canada) found extensive silver and zinc in Chañarcillo, but Apex Silver Mines Limited of Denver, Colorado, elected to drop its option to continue funding this initial drilling program in 2002; grade values at Chañarcillo were insufficient to indicate a viable bulk tonnage operation (Atna Resources Ltd., 2002c§). Atna Resources acquired the option to purchase Cerro Negro, which is a large copper oxide deposit, from a Chilean subsidiary of Phelps Dodge Corp. and with the approval of ENAMI, which owned Cerro Negro (Atna Resources Ltd., 2002b§). Although previous exploration carried out by Phelps Dodge outlined an overall resource of 191 Mt at a grade of 0.46% copper, Minera Atna Chile conducted some drilling and extensive metallurgical testing that focused more on higher grade oxide resources in 2002; initial results indicated more than Atna Resource's threshold of a 50-Mt resource at grades of more than 0.5% copper (Atna Resources Ltd., 2002d§). Minera Atna Chile acquired a 100% interest in the Celeste project claims that surrounded Cerro Negro. The best drill intersections in the Celeste claims included grades from 0.77% copper to 1.41% copper and lower grades of silver in the predominantly sulfide mineralization (Atna Resources Ltd., 2002a§).

During 2002, Coeur d'Alene Mines Corp. continued its exploration and development program at the Cerro Bayo deposit in Region XI, near the border with Argentina. The majority of the reserves within this primarily silver and gold trend was discovered in the Lucero vein, which was estimated to contain ore-grade mineralization for more than 3,300 feet (1006 meters) along strike and to approximately 350 feet (107 meters) in depth. In addition to a mineralized loop of the main Lucero vein, mineralized high-grade gold and silver vein systems were discovered along the same trend; these veins were named Andrea, Celia, Luz Eliana, and Soledad East. In 2002, development drifting and production activities were undertaken to the north and south along the Celia, Lucero, and Luz Eliana veins. Surface and underground diamond drill programs were also underway to test these vein structures for additional high-grade gold and silver mineralization. In 2002, total capital expenditures for exploration and development of the Cerro Bayo deposit

amounted to \$3.6 million, and Coeur d'Alene planned to expend approximately \$1.6 million of additional capital there in 2003 (Coeur d'Alene Mines Corporation, 2003, p. 13).

Production

In 2002, Chile was the world's leading copper producer and had about 30% of globally identified copper resources. Chilean copper production decreased by more than 3.3% compared with that of 2001. Chile's copper production still accounted for about 34% of world mine production of copper. CODELCO produced more than 11% of the world's copper in 2002 (Comisión Chilena del Cobre, 2003, p. 14, 15, 79). Following the historically low copper prices in 2001, CODELCO (2003, p. 17) opted to reduce production in 2002 by about 68,900 metric tons (t) of copper (Corporación Nacional del Cobre, 2003, p. 17).

In 2002, Chilean copper production was almost 4.6 Mt, which was a decrease of about 158,000 t from that of 2001. About 33.2% of the total, or more than 1.5 Mt, was contributed by CODELCO, and about 66.8% was produced by the private sector (Comisión Chilena del Cobre, 2003, p.14, 15). The production of large-sized mining companies contributed 90% of the total copper produced followed by the medium- and small-sized mines with 9% and 1%, respectively. Gold production decreased by 9.3% to 38,688 kilograms (kg) in 2002 and silver production decreased by about 10.3% to 1,210 t. The medium- and small-sized gold mines produced 61.8% of the gold, and the copper mines produced 38.2%. The medium- and small-sized silver mines produced 51.1% of the silver, and the copper mines produced 48.9% (Servicio Nacional de Geología y Minería, 2003, p. 20, 37, 40, 53, 56).

In 2002, copper prices fell to a 5-year low of less than \$0.71 per pound on the London Metal Exchange (LME). BHP Billiton Plc. and CODELCO continued to produce less than each company's original copper output estimates in 2002. From November 2001 to December 2002, BHP Billiton selectively mined lower grade sulfide ore at its majority-owned Escondida Mine and reduced output by 160,000 t. CODELCO lowered production by 100,000 t during the same time frame; responsibility was shared by all five of its operating divisions, but the largest cuts in production were at CODELCO's Chuquibambilla Mine. Reportedly, BHP Billiton intended to continue mining lower grades and to reduce its anticipated 2003 production of 1.25 Mt by about 200,000 t, and CODELCO was apparently planning to store about 200,000 t of its 1.6 Mt of expected 2003 output. Other copper producers did not appear to adopt similar strategies in response to the historically low copper prices in 2002, but some producers, such as Phelps Dodge, Noranda Inc., and Asarco Inc. (part of Grupo Mexico, S.A. de C.V.), made announcements that they would probably reduce or suspend higher cost operations outside of Chile if the copper market failed to improve (Tarbutt, 2002, 2003).

In 2002, BHP Billiton's Escondida Mine produced 758,000 t of copper, which was 4.5% less than that of 2001. It remained the world's largest copper mine and produced more than 5% of the world's copper (Mining Journal, 2003b). The level of copper production by CODELCO was 4.1% lower than that of 2001 mostly as a result of CODELCO's decision to reduce programmed production in 2002. In 2002, CODELCO's production of copper was more than 1.6 Mt, which included CODELCO's 49% share of El Abra Mine's production. The average ore grade of this copper production was 0.91% in 2002 compared with 0.97% in 2001. This appears to be a relatively large annual decrease because the average ore grade fell by only about 9% for the entire period from 1998 to 2002. In 2002, CODELCO also produced 19,901 t of molybdenum, which was about 18% lower than that of 2001 and represented 15% of the world's molybdenum production (Corporación Nacional del Cobre, 2003, p. 17, 46, 53).

In 2002, CODELCO's contribution to Chile's fiscal revenues reached \$326 million, which was 11.9% lower than that of 2001 owing to lower copper prices. In 2002, CODELCO's total income from copper and byproducts totaled about \$3.5 billion in 2002, which was 4.6% lower than that of 2001. Byproduct sales totaled \$500 million, which was \$52 million more than that of 2001. Molybdenum, which was the main byproduct, generated income worth \$151 million: this was \$29 million more than that of 2001 owing to higher prices, which compensated for the lower sales that resulted from the decision to lower production. Cathodes, fire-refined, and refined copper accounted for about 90% of sales and sales of unrefined copper products made up the remaining 10% (Corporación Nacional del Cobre, 2003, p. 20, 54).

In 2002, Antofagasta Minerals S.A. was the mining division of Antofagasta Plc. of London and operated a couple of large mining operations, Los Pelambres and El Tesoro Mines in 2002 as part of the mining cluster centered around the cities of Antofagasta and Iquique in northern Chile. Antofagasta Minerals' oldest mine was the smaller Minera Michilla S.A. in Region II. Overall, Antofagasta Plc.'s Chilean copper mines produced a record 460,700 t in 2002 compared with 445,000 t in 2001; more than 70% of the 2002 total was produced at Los Pelambres Mine (Tarbutt, 2002, 2003). Production at the new El Tesoro Mine was lower than expected in 2002 because it came onstream only in April (4 months late). This delay was also at least partially responsible for Antofagasta Minerals' production of copper and molybdenum concentrate to be lower than expected in 2002 (Mining Journal, 2003a).

In 2002, Compañía Minera Doña Ines de Collahuasi SCM, which was jointly owned by Falconbridge, Ltd. of Toronto, Canada (44%), London, United Kingdom-based Anglo American Plc. (44%), and a Japanese consortium (12%), produced 434,000 t of copper, which included 61,000 t of cathodes. The Doña Ines de Collahuasi Mine is located on the border with Bolivia and consists of two separate copper porphyries, Rosario and Ujina. Overall, the Doña Ines de Collahuasi Mine had reserves estimated to be 2,000 Mt at a grade of 0.83% copper in 2002 (Tarbutt, 2003). Falconbridge acquired a 100% stake in the Lomas Bayas Mine from the Swedish mining group Boliden Odde A.S. in 2001 and acquired a right to the neighboring Fortuna de Cobre deposit, which is located about 3 km away (Tarbutt, 2002). The Lomas Bayas Mine produced a record 59,300 t of copper cathode in 2002 and was to produce its planned 60,000 t/yr in 2003 (Falconbridge Limited, 2003, p. 2).

In 2002, the tax and ownership situation that surrounded the sale of the integrated Chilean copper producer Compañía Minera Disputada de Las Condes Ltda., which included Los Bronces open pit copper mine (180,000 t/yr in 2001), El Soldado open pit and underground copper mine (70,000 t/yr in 2001), and Los Chagres smelter (143,800 t of anodes and blister in 2001) to Anglo American

by Exxon Mobil Corp. of the United States was the subject of lengthy debate (Tarbutt, 2002). This sale was agreed to in May and slated to close at the end of June. It was delayed until nearly the end of 2002, however, while ExxonMobil and ENAMI reached an undisclosed settlement in October and Anglo American agreed to assume ExxonMobil's debt in 2002 for Minera Disputada in addition to agreeing to make a future contingent payment of up to \$120 million to ExxonMobil if the copper price exceeds certain levels between 2003 and 2008 (Mining Journal, 2002a). In 2002, legal settlements aside, Minera Disputada produced 300,000 t of copper from its Los Bronces and El Soldado Mines (Northern Miner, 2002).

In 2002, Aur Resources Inc. owned a 76.5% share in the Quebrada Blanca Mine in Region I, which produced 74,000 t of copper, 8,000 t of zinc, 341,000 troy ounces (10,600 kg) of silver, and 12,300 troy ounces (383 kg) of gold. In addition, Aur Resources' Andacollo copper mine was expected to produce 21,500 t of copper cathodes in 2002 (Mining Journal, 2002b).

The medium- and small-scale producers, which included a number of noncopper operations, were active during the year. In January, at the Aguas Blancas iodine property in Region II, the Chilean builder and operator ACF Minera S.A. produced 2 metric tons per day (t/d) of copper, which completed the first of the obligations the company was required to meet to retain the right to purchase 50% of the property from the owner Atacama Minerals Corp. of Vancouver, British Columbia, Canada. The property was officially opened in April. The second phase of obligations got under way in 2002 with the beginning of construction of the facilities necessary to produce sodium sulfate at Aguas Blancas in 2003. SC Minera Atacama Kozan, which was owned by Nittetsu Mining Co. Ltd. (60%) and Inverraz S.A. of Santiago (40%), completed construction of its \$60 million underground mine and flotation plant, and 90,000 t/yr of copper was expected to be produced by 2003 (Tarbutt, 2003).

Trade

Chile's economy was highly dependent on international trade. In 2002, the value of total exports accounted for more than 27% of the value of the GDP, which was about \$66.425 billion. Exports of copper accounted for about 34% of the total value of Chilean exports (Central Bank of Chile, 2003, p. 16, 65). In 2002, 14% of Chile's total copper exports went to China followed by, in descending order, the United States, Japan, Italy, and the Republic of Korea. CODELCO continued to follow very closely the changing process of economic development that has been going on in China. In 2002, China became the leading consumer of refined copper in the world; the United States dropped to second (Comisión Chilena del Cobre, 2003, p. 20, 91). In the mid-1990s, CODELCO began a strategy to increase its participation in the China market and, in the intervening years, has become the leading company selling copper to China (Corporación Nacional del Cobre, 2003, p. 17).

In 2002, nontraditional exports continued to grow faster than those of copper, other minerals, and other traditional exports. The value of total Chilean exports fell by 0.7% in 2002 owing to a decrease of 2.1% in the average price for Chile's exported goods despite the volume increasing by 1.4%. Copper exports decreased by 7.1% in value with the decrease of 3% in the volume of copper exported. Chilean exports of nontraditional goods increased by 3.6% in volume from 2001 but declined in value by 0.3% owing to an average 3.7% decrease in the price of Chile's nontraditional exports. In 2002, Chile's export markets were fairly balanced among Europe (24%), Asia (25%), Latin America (20%), and North America (21%). In looking at the change in total Chilean exports from 2001, however, exports increased mainly to Asia (8.9%) and to the United States (8.4%). The increase for Asia, which was the fastest growing export market, was due mostly to significant increases in exports to China, Taiwan, and the Republic of Korea, and exports to Japan decreased slightly. The United States, which was the largest single-country Chilean export market, accounted for about 21% of total exports; Japan, 11%; and China 7% (compared with 2.3% in 1999) (Central Bank of Chile, 2003, p. 34, 66; Lifsher, 2003).

The value of total Chilean imports fell by 3.8% in 2002 to \$20.7 billion, which was almost entirely the result of a decrease in the average price for Chilean imported goods of 3.9%. In 2002, the volume of Chile's imports increased slightly relative to that of 2001. This reflected reduced consumer demand and deferred investment in Chile. Capital goods made up about 22% of total imports, and the United States provided 18% of all Chilean imports in 2002. Chile was dependent upon copper exports (Central Bank of Chile, 2003, p. 34, 65). Considering only the impact of the Chilean trade balance on the economy, Chile's economic performance may be viewed as highly dependent on external mineral commodity demand and prices (U.S. Energy Information Administration, 2003\$).

Commodity Review

Metals

Aluminum.—In 2002, sources of alumina minerals in Chile were not significant, but that appeared to be only a minor concern of Noranda's in its continued attempts to develop a large aluminum smelter and hydroelectric project in Region XI. Contingent upon environmental approval by COREMA, Noranda proposed to invest at least \$2.75 billion in this aluminum reduction facility, Proyecto Alumysa Ltda., in 1994; the company was still planning to invest nearly \$3 billion in the project in 2002 if Noranda's environmental impact statement (EIS), which was filed with COREMA in August 2001 and was being reviewed by CONAMA in 2002, were to be approved (Metals & Minerals Latin America, 2001).

In 2002, Noranda was still projecting that Proyecto Alumysa will produce 440,000 t/yr of aluminum from alumina minerals imported from Australia, Brazil, or Jamaica depending on availability after completion of the project (Henriquez, 2002\$). Noranda's investment to get such a project operational would be quite extensive. The main features were designed to include three hydroelectric dams, additional port facilities, additional transmission lines, and various new and upgraded roads. As it stood in 2002, the project would still take 4 to 5 years from the approval date of an EIS to complete (Noranda Inc., 2001\$).

Serious questions, however, have been raised concerning the environmental impact of the project on this unique and fragile part of southern Chile, which is called the Aysén Region of Patagonia. In 2002, the EIS for Alumysa was sent back to Noranda for further revision, although it had already been extensively revised during the preceding 2 years, and discussions and negotiations continued on the EIS. On August 27, 2003, Noranda announced that it had decided to “temporarily suspend” some activities related to the Alumysa aluminum project and withdrew its EIS from the final stages of the approval process (Milliken, 2003§).

In 2003, Noranda appeared to be pursuing potential international partners in the project and to be continuing to work to overcome mostly political obstacles to the development of the project. In October 2003, the President of Chile appointed two ministers to salvage Alumysa, although he had clearly stated in August and prior to Noranda withdrawing its EIS that Aysén was not the place for such an aluminum plant. One likely reason for continuing Chilean interest in the project could be that Alumysa would represent the largest foreign investment in Chile as of yearend 2003. Given the region’s potential to generate hydropower, Noranda continued to believe in Aysén as an optimal site for aluminum smelting (Milliken, 2003§).

Copper.—According to the International Copper Study Group, world refined copper usage rose by 1.7% in 2002 compared with that of 2001, although it declined in many major markets, such as the United States (about 10%), over the same time period. Global copper prices averaged less than \$0.72 per pound in 2002, which was one of lowest annual copper price averages in the past 100 years (International Copper Study Group, 2004, p. 9, 22). Correspondingly, CODELCO posted less than \$369 million in pretax profits compared with more than \$412 million in 2001 (Corporación Nacional del Cobre, 2003, p. 114). Copper production in Chile decreased by about 158,000 t to 4.58 Mt, which was a 3.3% reduction in 2002 copper mine production compared with that of 2001 (Comisión Chilena del Cobre, 2003, p. 14).

In addition to the larger impacts of BHP Billiton and CODELCO reducing production from expected mine output of copper in 2002, the above decrease in Chilean copper production was affected by the severe winter conditions at Aur Resources’ 4,000-m-altitude Quebrada Blanca Mine. The harsh weather conditions during July and August resulted in an immediate copper production shortfall of 6.2 million pounds (about 2,800 t) and helped contribute to actual copper production in 2002 at Quebrada Blanca Mine to be 4,200 t lower than what was forecast in 2001. Aur Resources’ Andacollo copper mine, however, partially made up for this shortfall at Quebrada Blanca by exceeding its expected 2002 output. At Quebrada Blanca, Aur Resources also completed a \$20 million leaching project to raise future cathode production to 89,000 t/yr from 75,000 t/yr (Tarbutt, 2003).

The merger of BHP and Billiton in 2001 meant that the Cerro Colorado and Escondida copper mines were operated by BHP Billiton in 2002. A \$41 million expansion at the Cerro Colorado Mine, which involved retreatment of tailings and infrastructure improvements, received approval from environmental authorities and was expected to increase copper cathode production to 130,000 t/yr from 100,000 t/yr when it is completed. At the Escondida Mine, the Phase IV expansion was completed in 2002 and should increase copper production potential to as much as 400,000 t/yr by 2008 even if slightly lower grades are found. In the longer term, BHP Billiton’s Spence project, which is located north of Antofagasta City, had estimated reserves of 400 Mt at an average grade of 1% copper. Construction was scheduled to begin sometime in early 2003 with a production capacity of 250,000 t/yr of copper (Tarbutt, 2002, 2003).

BHP Billiton controlled 57.5% of the Escondida Mine; Rio Tinto Plc., 30%; a Japanese consortium, 10%; and International Finance Corp., 2.5%. BHP Billiton submitted an EIS for a process that would treat low-grade sulfide material by means of bio-assisted dump leaching at its majority owned Escondida Mine. Construction could begin as early as 2004, and the first stage could be commissioned in 2006. The project was at the feasibility stage, but no decision to proceed was made in 2002; development would depend on demand for copper. The low-grade sulfide resources totaled 2,300 Mt at an average grade of 0.55% copper (almost one-half of the contained copper is in the form of chalcopyrite), of which 86 Mt was waste from earlier mined material (Mining Journal, 2003b). The feasibility study for the \$535 million Escondida Norte open pit, which is located 5 km to the north, continued through 2002. A prefeasibility study for the \$435 million, sulfide-dump-leaching project to process lower grades at Escondida Norte was also completed in 2002 (Tarbutt, 2003).

Much of the principal expenditures by CODELCO in 2002 were used to continue the expansion project in the El Teniente Division with the target of increasing production to 500,000 t/yr by 2005. By the end of 2002, the project was 76% complete at an annual cost of \$636 million; its completion cost was projected to approach \$1.1 billion. In 2002, CODELCO also expended a large amount of its budget to begin a project to change to the Falconbridge permanent cathode process at the Chuquicamata Mine and had a target of raising production to 855,000 t/yr by 2005. Within 33 to 35 months after the end of 2002, this second project was expected to achieve a production level of 1.08 million metric tons per year of copper for the Chuquicamata Division and to cost CODELCO about \$195 million. A \$12 million contract was signed with SNC-Lavalin Inc. of Canada and Paul Wurth S.A. of Luxembourg in November 2001, and preliminary construction started in June 2002 (Tarbutt, 2003).

CODELCO began basic engineering work at its Gaby and Mansa Mine projects in northern Chile. According to CODELCO, Gaby has a resource of 400 Mt of oxide at grade of 0.54% copper and was expected to produce between 70,000 and 120,000 t/yr of cathodes. During 2002, the mining and metallurgical plans of the project were revised, and progress was made in preparing the EIS and in obtaining approval of the plans for the industrial water supply. During the period, \$3.8 million was spent on the project. The Mansa Mine project is located between Calama and Chuquicamata at 2,400 m above sea level. This project will mine and beneficiate ores from the central part of the Mansa Mine sulfide deposit, which contains 882 Mt of mineral resources with a copper grade of 1.09%, 16 g/t of silver, and 703 parts per million (ppm) of arsenic. In 2002, progress was made in updating the profile engineering, collecting information for the conceptual engineering, building an exploration ramp, and studying how to integrate the facility into CODELCO’s Norte Division (Corporación Nacional del Cobre, 2003, p. 36, 38).

During 2002, Alliance Copper Ltd., which was jointly owned by BHP Billiton and CODELCO, was testing the commercial viability of CODELCO's bioleaching technology (BioCOP[®]) and was constructing a \$60 million pilot plant to leach arsenic-bearing sulfide concentrates at Chuquicamata. Existing facilities will be used to electrowin 20,000 t/yr of cathodes. Alliance Copper and CODELCO reached preliminary agreement to use this technology to process 100,000 t/yr of cathodes from concentrates from the Mansa Mine (Tarbutt, 2003).

In 2002, plans to develop the Cuprochlor process, which was patented in 2001 by its developers at Minera Michilla, were still being evaluated (presumably by the operators of Michilla Mine, Antofagasta Minerals). Minera Michilla produced 50,000 t of copper cathode in 2002 because it was able to get cash costs down below \$0.60 per pound by the beginning of the year. Antofagasta Minerals' Los Pelambres Mine, which is located in Region IV, produced 324,600 t of copper in 2002; a 100,000-t/yr expansion remained under review (Tarbutt, 2002, 2003). Higher head grades were encountered by the end of 2002 at the mine where potential expansion of copper production appears to be on hold only until market conditions improve sufficiently. Although Antofagasta Minerals' new El Tesoro Mine was in operation only during the second half of the year, it produced 84,300 t, or 9.1% more copper during the fourth quarter of 2002 compared with that of the third quarter of 2002. Plans for continued expansion at El Tesoro also appear to be awaiting improved market conditions (Mining Journal, 2003a).

In 2002, a \$506 million plant expansion at the Doña Ines de Collahuasi Mine was authorized, and principal contracts were awarded at the end of 2002. The concentrator will be expanded to 110,000 t/d from 60,000 t/d to compensate for the expected lower grades that will result from the \$148 million transfer of ore production to the Rosario pit from the Ujina pit. The expansion of the mine was on schedule to be completed by 2004. Total production was anticipated to increase to about 500,000 t/yr of copper for a few years after that and then to fall back to approximate 2002-03 levels of about 400,000 t/yr (Tarbutt, 2003).

Falconbridge operated the Lomas Bayas copper mine in 2002. Noranda intended to purchase the mine jointly with Falconbridge before agreeing that Falconbridge would make the acquisition alone in 2001 (Tarbutt, 2002). At the end of 2002, this distinction in ownership became somewhat moot when Noranda acquired a 59.5% majority ownership of Falconbridge (Falconbridge Limited, 2003, p. 1). During 2002, both Falconbridge and Noranda worked together and completed a \$20 million project to expand the solvent extraction (SX) section and to develop the low-grade heap-leach ore at the Lomas Bayas Mine. These projects were expected to be involved in the mine's production in 2003. An EIS that estimated the environmental impact of maintaining cathode production of 60,000 t/yr at about \$15 million was presented to the Government in 2002 (Tarbutt, 2003). In 2002, Noranda Chile operated the Altonorte copper smelter, which is located on the outskirts of Antofagasta, and continued a \$170 million expansion of this smelter. This expansion was on schedule to be completed in 2003 and was projected to expand the Altonorte smelter's copper production to 290,000 t/yr from about 160,000 t/yr (Noranda Inc., 2003§).

By the end of 2002, Anglo American completed its acquisition of the 250,000-t/yr Minera Disputada from ExxonMobil. Completion of the agreement to sell Minera Disputada for \$1.3 billion was delayed by two unanticipated issues. The first involved a claim by ENAMI that it held an option to acquire a minority interest in Minera Disputada. ExxonMobil acquired Minera Disputada from ENAMI for \$92 million in 1978 and subsequently invested \$1.2 billion in its development. ENAMI raised a legal challenge to ExxonMobil's agreement to sell Minera Disputada to Anglo American because the 1978 sale agreement gave ENAMI an option to acquire 49% in Minera Disputada until 2028. ExxonMobil filed a counter suit that stated that it had never denied ENAMI's right to the option. ExxonMobil and ENAMI reached an undisclosed settlement on October 25, 2002. The second issue was a concern on the part of the Chilean Government that the form of the sale would allow ExxonMobil to avoid capital gains taxes. The sale was restructured so that a tax of about \$40 million would be incurred. Anglo American's payment of \$1.3 billion to ExxonMobil for the purchase of Minera Disputada included the assumption of debt that amounted to \$238 million (Mining Journal, 2002a).

Gold and Silver.—Production of gold in 2002 was 9.3% lower than that of 2001 in Chile. By mid-2002, mining by CODELCO's and Minera Homestake Chile S.A.'s joint venture, Agua de la Falda S.A., was stopped, and operations to close the mine at the Agua de la Falda gold deposit owing to exhaustion of the ore began. With the washing of the leaching dumps at the deposit scheduled to be completed by June 2003, the future of this joint venture beyond 2003 will depend on the viability of gold and other ore deposits in Region III, such as the Manto Jerónimo gold deposit. In 2000, when Manto Jerónimo appears to have been last explored by Agua de la Falda, gold reserves were estimated to be about 500,000 troy ounces (16 t) of gold (Corporación Nacional del Cobre, 2001, p. 13; 2002, 62).

At the end of 2001, Barrick Gold Corporation completed its merger with Homestake Mining Co., which meant that their Chilean subsidiaries, Barrick Chile Ltd. and Minera Homestake Chile, were effectively under one roof in 2002 (Mining Magazine, 2002). In 2002, Barrick Chile began a planned 4-year closure operation of its El Indio gold mine in northern Chile, which was projected to cost about \$45 million. Waste dumps were being contoured, and leach heaps flushed for cyanide, which was then treated before release. Buildings were being removed, and the Rio Malo was being channeled through the dumps area. Arsenic levels from waters that drain the site were to be reduced at least to background levels (Tarbutt, 2003). Barrick Chile did not pursue any further reserve developments at its Pascua-Lama gold-silver project on the Chile-Argentina border where proven and probable reserves remained at 16.9 million troy ounces (526 t) of gold and 594 million troy ounces (18,500 t) of silver. In 2002, production targeted at 800,000 troy ounces per year (25 t/y) of gold was expected to commence in 2008 at Pascua-Lama (Barrick Gold Corporation, 2003, p. 30).

In 2002, Compañía Minera Mantos de Oro, which was a 50-50 joint venture between Placer Dome Inc. of Vancouver, British Columbia, Canada, and TVX Gold Inc., of Toronto, Ontario, Canada, operated La Coipa gold mine in Region III. Gold and silver are accounted for as co-products at La Coipa Mine. La Coipa Mine produced 298,569 troy ounces (9,287 kg) of gold and 3.6 million troy ounces (110 t) of silver in 2002. Approval of a merger of TVX with Kinross Gold Corp., also based in Toronto, was still being

finalized at the end of 2002 and was expected to be completed at the beginning of 2003. As a result of the merger, TVX's share of Minera Mantos de Oro will be owned by Kinross (Placer Dome Inc., 2003, p. 51; Kinross Gold Corporation, 2003§).

In 2001, Coeur d'Alene closed its El Bronce de Petorca gold and silver mine in Region V, but did not sell Compañía Minera El Bronce de Petorca back to the Callejas Zamora family until August 30, 2002. Coeur d'Alene brought the ore-processing mill at the Cerro Bayo Mine (formerly the Fachinal Mine) into production in April, 2002. This processing facility, Cerro Bayo Ltda., used a standard flotation process to produce gold and silver concentrate, which was then sold to third-party smelters primarily in Japan. The mill had a design capacity of 1,650 t/d. Coeur d'Alene estimated recovery rates of 89% for silver and 88% for gold. During 2002, Coeur d'Alene completed a new road to the Furioso property, which is located approximately 50 miles southwest of Cerro Bayo. Coeur d'Alene then began hauling Furioso ore to Cerro Bayo for processing in the second quarter of 2002 at a cost of \$1.8 million. In addition, Coeur d'Alene began mining operations in June 2002 at the Martha Mine, which is located just across the border in Argentina, where there were no processing facilities. Ore from the Martha Mine was transported to Cerro Bayo to be processed beginning in the final two quarters of 2002. Only the consolidated production was reported. In 2002, Coeur d'Alene reported 45,209 troy ounces (1.4 t) of gold production and 3,112,169 troy ounces (97 t) of silver production from the Cerro Bayo/Martha Mine (Coeur d'Alene Mines Corporation, 2003, p.13-15).

Iron Ore.—Chilean production of iron ore was just under 7.3 Mt in 2002, which was a decline of 17.2% compared with that of the previous year. Compañía Minera del Pacifico S.A. produced about 5.2 Mt of this ore at its El Algarrobo Mine in Region III; the ore was used to produce almost 3.9 Mt in iron pellets at its Huasco Valley pellets plant, Compañía Minera Huasco S.A., in 2002. Minera del Pacifico produced the remaining 2.1 Mt of ore at its El Romeral Mine in Region IV. Chile exported slightly less than 2.4 Mt of iron ore and almost 3.9 Mt of raw iron, mostly in pellet or chip form. Compañía Siderúrgica Huachipato S.A. was the largest domestic processor of iron ore from Chilean mine production (Servicio Nacional de Geología y Minería, 2003, p. 67-69).

Lead and Zinc.—In 2002, Chile produced 36,161 t of zinc, which was almost all produced from zinc concentrate, but some was produced from gold concentrate. This was a 10.4% increase compared with that of 2001. Lead production reached 2,895 t in 2002, which was mostly from gold concentrate; the remainder was from zinc concentrate. Overall, this was a 143% increase compared with lead production in 2001. Sociedad Contractual Minera El Toqui Ltda. was a subsidiary of the Canadian base-metals producer Breakwater Resources Ltd. and was responsible for almost all zinc and lead production in Chile in 2002 (Servicio Nacional de Geología y Minería, 2003, pp. 63). El Toqui Mine, which is an underground gold and zinc mine located in Region XI, produced 35,907 t of zinc in 2002, which was 10% more than was produced in 2001. Metallurgical improvements during 2002 resulted in a zinc recovery increase to 92.1% from 89.9% in 2001 and a concentrate grade increase to 50.8% from 49.8% zinc in 2001. In 2002, work began on developments that would increase El Toqui Mine's production capacity by about 25% in 2003; these included development of the Asseredero area to greatly enhance the gold grade of the mill feed for the next few years and the construction of a new ramp within the mine to access new reserves. El Toqui Mine also produced 4,682 troy ounces (146 kg) of gold and 282,383 troy ounces (8,783 kg) of silver in 2002 (Breakwater Resources Ltd., 2003, p. 9-10).

Manganese.—During 2002, Manganos Atacama S.A. produced 12,195 t of manganese from ore mined by small- and medium-sized mining firms in Region IV. Although this was a 61% decrease in production compared with that of 2001, Manganos Atacama was still able to distribute about 15,000 t of manganese to the domestic market. The remainder was apparently provided out of stockpiles at its industrial plant, which was located at Coquimbo (Servicio Nacional de Geología y Minería, 2003, p. 70).

Industrial Minerals

Iodine and Nitrates.—During the last half of 2002, international prices for specialty fertilizers and iodine started to stabilize (Sociedad Química y Minera, 2003, p. 2). In 2002, Chile produced almost 1.2 Mt of sodium nitrate, potassium nitrate, and other nitrates (Servicio Nacional de Geología y Minería, 2003, p. 103). Most of this production was by SQM Nitratos S.A. in Antofagasta where production of nitrates increased to 894,700 t from 849,700 t in 2001 (Sociedad Química y Minera, 2003, p. 30). In 2002, SQM was also the major producer of the more than 11,600 t of iodine produced in Chile (Servicio Nacional de Geología y Minería, 2003, p. 103). The company produced about 6,400 t of iodine and iodine derivatives in 2002, which was an increase from the 5,600 t produced in 2001 at plants in Antofagasta and Iquique. In 2002, SQM consolidated a commercial alliance with Norsk Hydro A.S.A. of Norway in the specialty fertilizer business area, which was agreed to in 2001. In 2002, SQM produced more than 1.2 Mt/yr of brines at its mining and production facilities in the middle of the Atacama Desert and exported approximately 90% of its overall production. SQM was the leading producer of potassium nitrate in the world with close to a 45% international market share in 2002 and was the leading producer of iodine in the world with a 29% international market share in 2002 (Sociedad Química y Minera, 2003, p. 10, 15, 19, 21, 31).

PCS Yumbes S.C.M. (a subsidiary of Potash Corporation of Saskatchewan, Inc.) started producing potassium nitrate, sodium nitrate, and similar products in 2002. Potash Corp. owned 37.5% of SQM's series A shares and elected two out of eight of SQM's directors for the 2002 fiscal year. In 2002, SQM supplied PCS Yumbes with potassium chloride, which is a raw material used in the production of potassium nitrate, and PCS Yumbes sold about 100,000 t back to SQM (Sociedad Química y Minera, 2003, p. 30, 33). The total amount of the commodity produced by PCS Yumbes in 2002 is, however, not apparent in the published data.

Atacama Minerals reported that a Phase II iodine and sodium sulfate expansion program at Aguas Blancas in Region II was on schedule to get underway in 2003. With respect to iodine production, expansion in production was expected as a result of conversion to a mechanical leaching plant from a heap-leach operation by 2004. In January 2002, the builder and operator ACF Minera completed the first phase of its 50% earn-in option from Atacama Minerals (Tarbutt, 2003). If ACF Minera completes the remaining conditions of this option agreement, then Atacama Minerals would control the remaining 50% interest in the project through a new more targeted Chilean subsidiary Inversiones Aguas Blancas Ltda. During 2002, Atacama Minerals conducted operations at Aguas Blancas jointly with ACF Minera through Atacama Minerals' more general Chilean subsidiary Atacama Minerals Chile S.C.M. This joint venture reported production of only iodine in 2002, which totaled about 710 t during the 10 months that the project was in operation (Atacama Minerals Corp., 2003, p. 4).

Atacama Minerals projected that 2003 would be its first full year of production at Aguas Blancas and that production would reach 1,500 t/yr of iodine by 2004, subject, of course, to market conditions. In addition to increased iodine production, the heap-leaching plant was expected to facilitate production of sodium nitrate and sodium sulfate, if another partner could be found to help complete this final phase of project development. If completed, then Aguas Blancas was expected to have the capacity to produce up to 300,000 t of sodium sulfate, approximately 100,000 t of sodium nitrate, and more than 1,400 t of iodine (Atacama Minerals Corp., 2003, p. 4; 2004, p. 3). In 2002, the other firms that produced iodine in Chile were Compañía Industrial y Minera S.A., Cosayach Primera Región S.A., and DSM Minera S.A. (a subsidiary of Royal DSM N.V. of Heerlen, the Netherlands) (Servicio Nacional de Geología y Minería, 2003, p. 103).

Mineral Fuels

Coal.—In 2002, bituminous coal output was reported to be 452,022 t, which was 21.8% less than that of 2001. Coal was produced mainly by Carbonífera Victoria de Lebu S.A. and ENACAR; several small privately owned coal companies, such as La Compañía Carbonífera San Pedro de Catamutún, also operated in Chile. In 2002, domestic coal production was located in Regions VIII and XII (Servicio Nacional de Geología y Minería, 2003, p. 106, 107). Recoverable reserves of coal in Chile were estimated to be less than 1.2 billion metric tons (Bt). The coal was of low quality, and production costs were high. Coal production declined greatly during the past decade, and the country's largest coal mine was closed in 1997. In 2002, coal was produced only in the Lota/Coronel area and in Tierra del Fuego. In 2002, Chile consumed about 3.7 Bt, which meant that the country had to import almost 88% of the coal consumed. Imports from Australia amounted to 36% of total coal imports; Indonesia, 31%; Canada, 18%; New Zealand, 4% (U.S. Energy Information Administration, 2004§). In 2002, coal was primarily consumed when there were shortages of hydropower in Chile. Therefore, coal consumption was expected to fluctuate considerably during the following years but to increase annually (U.S. Energy Information Administration, 2003§).

Natural Gas.—In 2002, production of natural gas in Chile was low and declining especially in comparison with consumption. Production of natural gas reached 2,543 million cubic meters, which was a decrease of 5.3% compared with that of 2001 (Servicio Nacional de Geología y Minería, 2003, p. 108). Historically, a power shortage in the late 1990s, which resulted from a severe drought that greatly reduced hydroelectric power generation, led Chile's National Energy Commission (CNE) to call for the increased use of natural gas in Chile's energy mix. Many industries had access to natural gas by 2001, and residential users in the larger cities were being connected to the gas transmission system. Since 1997, four natural gas pipelines have been completed and were transporting natural gas from Argentina by 2002. These developments resulted in Chile being highly dependent on natural gas imports from Argentina. Labor unrest in Argentina and a rupture in the NorAndino pipeline temporarily disrupted natural gas supply to Chile in 2002. This led the CNE to consider many adjustments to the long-term energy strategy, which included establishing a legal requirement that new natural-gas-fired powerplants also be able to burn fuel oil (U.S. Energy Information Administration, 2003§).

In 2002, Chile hoped to diversify natural gas imports by becoming a liquefaction terminal for Bolivian natural gas en route to Mexico and the United States, but a majority of Bolivians preferred a Peruvian to a Chilean port, owing to Bolivia's loss of its only outlet to the sea to Chile in the War of the Pacific in the 19th century. In 2003, a referendum on whether to export natural gas through Chile or Peru was to be held in Bolivia in August. In 2002, the production and importation of natural gas in Chile was the responsibility of ENAP (U.S. Energy Information Administration, 2003§).

Petroleum.—Chile produced only 2.1 million barrels (Mbbbl) of crude, which was a decline of 12.8% compared with that of 2001 (Servicio Nacional de Geología y Minería, 2003, p. 108). In 2002, ENAP was the only producer of petroleum in Chile; operations were concentrated in the Magallanes Basin in Region XII. In 2002, Chilean crude oil reserves were estimated to be about 150 Mbbbl. Chile's crude oil production declined by about 74% from 1982 to 2002, and consumption increased by about 135% in the same timeframe. As a result, Chile has steadily increased imports of oil (U.S. Energy Information Administration, 2003§).

In 2002, Chile consumed 245,000 barrels per day (bbl/d); domestic production comprised only 3% of the total consumption. Chile's dominant source of imported oil was Argentina (74% of all Chilean oil imports); a few other countries, such as Brazil (8%), Nigeria (7%), Peru (6%), Venezuela (3%), and Malaysia (2%), were responsible for most of the remainder. Sipetrol S.A. (the foreign exploration and production subsidiary of ENAP) owned production operations in Argentina, Colombia, Ecuador, and Egypt in 2002, and produced about 25,000 bbl/d of oil equivalent. Sipetrol was considering expanding operations in the Middle East. Oil and gas distribution was liberalized in Chile, thus allowing free access to imported petroleum products in 2002, but ENAP continued to seek joint-venture partners to reactivate its idle and declining fields in the Magallanes Basin (U.S. Energy Information Administration,

2003§). In 2002, ENAP also produced many oil-derivative products from imported petroleum as part of its operations in the Basin (Servicio Nacional de Geología y Minería, 2003, p. 110).

Infrastructure

Chile had a 6,585-km railway system. The railway system served all the important agricultural, industrial, and mining areas from Region I (Iquique) to Region X (Puerto Montt). During the past 11 years, almost no investment has been made in the railways. Empresa de Ferrocarriles del Estado was the largest government-owned railway in 2002 (U.S. Central Intelligence Agency, 2003§).

The pattern of highways was similar to that of the railways. The road system totaled 79,800 km, of which 11,012 km was paved and 68,788 km was unpaved. The country had 71 airports with paved runways of more than 3,047 km (U.S. Central Intelligence Agency, 2003§).

International trade of mineral commodities, chiefly copper and its byproducts, was handled through the ports of Antofagasta, Arica, Chañaral, Coquimbo, Iquique, Puerto Montt, Punta Arenas, San Antonio, San Vicente, Talcahuano, and Valparaíso; they handled almost 60% of the total tonnage (U.S. Central Intelligence Agency, 2003§).

Chile had 755 km of pipelines for crude petroleum, 785 km for refined products, and 320 km for natural gas. In addition, a 450-km 41-centimeter-diameter oil pipeline was expected to transport crude oil from Argentina's Puesto Hernandez oilfields to Chile's Talcahuano terminal in the near future, and a 1,200-km natural gas pipeline between gasfields in Neuquén and Santiago was planned (U.S. Central Intelligence Agency, 2003§).

Outlook

In 2002, previously steady growth in Chilean copper production slowed down a bit owing to the lowest copper prices in 5 years, but it could be rapidly restored if global demand continues to grow, especially in China, and if several expansion projects prove to be feasible, given ongoing uncertainty in international copper prices. Such recovery may not happen in 2003, but Chile appears to have the production capacity to recover much of this temporary copper production slowdown in the next 3 to 4 years. Two major copper producers, BHP Billiton and CODELCO, do not appear interested in continuing strategies of reduced production beyond 2003, and there is substantial viable competition in the Chilean copper industry to make up for any reasonably expected future slowdowns in copper production by these two big producers.

Copper prices were not the only commodity prices that experienced a decline in 2002. On the basis of production capacity, production of gold, iodine, molybdenum, nitrates, silver, sodium sulfate, and zinc could be expanded during the next 3 to 4 years if conditions improve in the international markets for each of these mineral commodities. Other mineral commodities for which 2002 production was down from previous levels, such as manganese, are harder to evaluate concerning future expansion in production because the firm(s) appear(s) to have some stockpiles that are not well accounted for in the published data.

One sector for which 2002 decreases in production did not appear to be temporary was in the energy sector where Chile has limited indigenous resources and relies on imports for most of its hydrocarbon needs. The CNE appears to be rethinking the country's long-term energy strategy. Continued reliance upon hydropower for Chile's electricity needs does not appear to be avoidable any time soon, but strategies to smooth electricity provision by diversifying the backup technologies, which include a requirement for more oil-burning capability, appear to be important steps in a revised energy strategy (U.S. Energy Information Administration, 2003§).

In a related 2002 development, the Chilean Government did not appear to be willing to allow a new hydropower plant to be built by Noranda in the Patagonia region. The President's concern, which was voiced in public in August 2002, appears to be based on a concern for the environment, but given Chile's energy situation, more electricity from any proposed plant is likely to be made available for public consumption before such a project could become viable from Chile's socioeconomic perspective. Government negotiations with Noranda are ongoing. The large amount of the potential foreign investment and the potential amount of electricity to be generated from this project appear to be serious considerations.

The copper industry will most likely continue to lead the mining sector and the Chilean economy in terms of GDP and exports, certainly during the next 3 to 4 years. The low copper prices in 2002, however, provided an opportunity to examine the state of diversity in the minerals sector, Chilean exports, and the wider economy. The lack of response in the production of other mineral commodities and in other sectors of the Chilean economy to copper hitting its lowest price in 5 years implies that economists should carefully consider Chilean progress in economic diversification when considering any future outlook (Tarbutt, 2003). Starting in 2003, the bilateral U.S.-Chile Free Trade Agreement and the increased access it provides to one of the most diversified consumer markets in the world should allow an even greater opportunity for Chile to diversify its export portfolio during the next 3 to 4 years. Even in 2002, Chile's nontraditional exports grew faster than those of copper, other minerals, and more traditional exports. If copper prices recover in the coming years and this promising trend towards greater diversification is still significantly observable, then that would be considerable evidence that Chile's economic growth and development in the coming years will be at least as positive as it has been in recent years.

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Major Publications

Comisión Chilena del Cobre: Estadísticas del Cobre y otros Minerales, 1993-2002.

Corporación Nacional del Cobre de Chile: Annual Report, 2002.

Servicio Nacional de Geología y Minería: Anuario de la Minería de Chile, 2002

TABLE 1
CHILE: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002
METALS					
Arsenic trioxide ^c	8,400	8,000	8,000	8,000	8,000
Copper:					
Mine output, Cu content ³ thousand tons	3,687	4,391	4,602	4,739	4,581
Metal:					
Smelter, primary ⁴ do.	1,403	1,474	1,460	1,503	1,439
Refined: ⁵					
Fire-refined, primary do.	1,108	1,362	1,373	1,538	1,602
Electrolytic do.	1,227	1,304	1,296	1,344	1,248
Total do.	2,335	2,666	2,669	2,882	2,850
Gold, mine output, Au content kilograms	44,980	48,069	54,143 ^r	42,673	38,688
Iron and steel:					
Ore and concentrate:					
Gross weight thousand tons	9,112	8,345	8,729	8,834	7,269
Fe content do.	5,694	5,215	5,455	5,437 ^r	4,398
Metal:					
Pig iron do.	993	1,030	1,024	897 ^r	964
Ferroalloys:					
Ferrochromium ^c	2,000	2,000	2,000	2,000	2,000
Ferromanganese	3,652	2,833	4,011	2,213 ^c	2,500 ^c
Ferromolybdenum	1,978	2,079	1,454	1,784 ^c	1,600 ^c
Ferosilicomanganese	3,921	2,048	1,800	1,800 ^c	1,800 ^c
Ferosilicon	1,159	1,000	1,100 ^c	1,100 ^c	1,100 ^c
Total	12,710	9,960	10,365	8,897 ^c	9,000 ^c
Steel, crude ⁶ thousand tons	1,171	1,291	1,352	1,247	1,280
Semimanufactures do.	1,060	1,303	1,300 ^c	1,067 ^r	1,150
Lead, mine output, Pb content	337	608 ^r	785	1,193	2,895
Manganese ore and concentrate:					
Gross weight	48,931	40,505	41,716	31,320	12,195
Mn content	14,345	11,915	12,271 ^r	9,130 ^{r, c}	3,190 ^c
Molybdenum:					
Mine output, Mo content	25,297 ^r	27,309 ^r	33,187 ^r	33,492 ^r	29,466
Oxides	13,678	10,000	12,000	8,813	8,500 ^c
Rhenium, mine output, Re content ^{c, 7} kilograms	12,800 ^r	14,000 ^r	17,100 ^r	17,800 ^r	15,400
Selenium ^{c, 7} do.	49,000	49,000	40,000	40,000	40,000
Silver	1,340	1,381 ^r	1,242 ^r	1,349 ^r	1,210
Zinc, mine output, Zn content	15,943	32,263	31,403 ^r	32,762	36,161
INDUSTRIAL MINERALS					
Barite	1,430	823	1,026	584	384
Borates, crude, natural, ulexite	280,140	324,691	337,966	327,743	431,293
Cement, hydraulic thousand tons	3,888	3,036	3,377	3,513 ^c	3,522 ^c
Clays:					
Bentonite	721	1,104	1,314	1,695	1,632
Kaolin	11,530	4,361	6,445	5,300	6,164
Other, unspecified	5,040	53,721	23,387	28,330	35,091
Diatomite	14,868	14,477	13,384	22,705	30,274
Dolomite	16,473	20,016	12,506	29,940	31,439
Feldspar	1,460	1,346	2,311	2,867	3,069
Gypsum:					
Crude thousand tons	781	886	376	517	610
Calcined do.	246	188	176	175	229
Iodine, elemental	9,722	9,317	10,474	11,355	11,648
Lapis lazuli ^c kilograms	58 ⁸	100	100	100	100
Lime, hydraulic ^c thousand tons	1,000	1,000	1,000	1,000	1,000
Lithium carbonate	28,377	30,231	35,869	31,320	35,242

See footnotes at end of table.

TABLE 1--Continued
CHILE: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity ²	1998	1999	2000	2001	2002
INDUSTRIAL MINERALS--Continued					
Nitrogen, natural, crude nitrates:					
Sodium, NaNO ₃ thousand tons	722	751	800	868 ^e	951
Potassium, KNO ₃ do.	160	165	188	204 ^e	223
Total do.	882	916	988	1,072	1,174
Phosphate rock, apatite	15,065	12,074	12,474	11,511	11,068
Pigments, mineral, natural, iron oxide	10,449	9,992	10,000 ^e	10,000 ^e	10,000 ^e
Potash, K ₂ O equivalent	280,000	312,000	330,000 ^e	390,000 ^e	350,000 ^e
Potassium chloride, KCl ^c thousand tons	800	600	550	648 ^e	665
Pumice, including pozzolan do.	912	958	830	785	826
Quartz, common do.	641	577	576	538	879
Salt, all types do.	6,207	6,074	5,083	5,989	3,503
Sodium compounds, n.e.s., sulfate ⁹	51,928	58,026	56,501	67,760	70,776
Sand and gravel, silica ^c thousand tons	300	300	300	300	300
Stone:					
Limestone, calcium carbonate thousand tons	5,999	5,618	5,395	5,563	5,888
Marble	1,427	828	812	782	633
Sulfur, byproduct, from smelters and oil ref.	899,000	1,040,000	1,100,000	1,160,000	1,275,000
Talc	3,772	2,231	2,421	4,177	3,537
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous and lignite thousand tons	231	508	509	578	452
Coke, coke oven do.	476	511	500 ^e	500	440
Gas, natural:					
Gross million cubic meters	3,218	2,957	2,702	2,684	2,543
Marketed ^c do.	1,900	1,900	1,900	1,900	1,800
Natural gas liquids: ^c					
Natural gasoline thousand 42-gallon barrels	1,100	1,000	1,000	1,000	1,000
Liquefied petroleum gas do.	2,880	2,000	2,500	2,500	2,500
Total do.	3,980	3,000	3,500	3,500	3,500
Petroleum:					
Crude thousand 42-gallon barrels	2,948	2,314	2,050	2,425	2,116
Refinery products: ^c					
Liquefied petroleum gas do.	5,350	5,200	5,200	6,265 ^s	6,260
Gasoline:					
Aviation do.	75	80	80	5,384 ^s	5,400
Motor do.	16,700	16,700	16,700	17,530 ^s	17,500
Jet fuel do.	4,350	4,390	4,390	5,384 ^s	3,400
Kerosene do.	2,150	2,250	2,250	1,283 ^s	1,280
Distillate fuel oil do.	21,500	21,800	21,800	22,096 ^s	22,100
Residual fuel oil do.	12,100	12,200	12,200	12,857 ^s	12,860
Unspecified do.	4,650	4,750	4,750	4,221 ^s	4,220
Total do.	66,900	67,400	67,400	75,020 ^s	73,020

^eEstimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. ^rRevised.

¹Table includes data available through September 2003.

²In addition to the commodities listed, pyrite is also produced, but available information is inadequate to make reliable estimates of output levels.

³Figures are the nonduplicate copper content of ore concentrates, cement copper, slags and minerals, and copper as a byproduct measured at the last stage of processing as reported by Comisión Chilena del Cobre (COCHILCO). Mine production reported by Servicio Nacional de Geología y Minería was as follows, in thousand metric tons: 1998--3,764; 1999--4,422; 2000--4,646; 2001--4,766; and 2002--4,620.

⁴Detailed statistics on electrowinning were reported by the International Copper Study Group Copper Bulletin (September 2002) as follows, in thousand metric tons: 1998--1,108; 1999--1,362; 2000--1,373; 2001--1,538; and 2002--1,602.

⁵Figures are total refined copper distributed into two classes according to the method of refining—fire-refined or electrolytic, which includes electrowon copper refined in Chile, as reported by COCHILCO.

⁶Excludes castings.

⁷Rhenium output was revised based on new information from the COCHILCO and includes rhenium content from MOLYMEX S.A. de C.V. (Mexico) processed at Molibdenos y Metales S.A. (MOLYMET) in Santiago, Chile.

⁸Reported figure.

⁹Includes production of anhydrous sodium sulfate and natural sodium sulfate, which are coproducts of the nitrate industry (salitre).

TABLE 2
CHILE: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Coal:				
Bituminous		Empresa Nacional del Carbón S.A. (ENCAR) (Government, 100%)	Three mines (Colico, La Chulita, and Trongol) and a Planta Lota in Lota, Curanilahue in Region VIII	82,000.
Subbituminous		Cía. de Carbones de Chile (COCAR) S.A. [Cía. de Petroleos de Chile S.A., 45.05%; International Finance Corp. (IFC), 9.9%; Inversiones Ultraterra S.A., 45.05%]	Pecket Coal mine, Region XII (open pit mine)	340,000.
Copper		Corporación Nacional del Cobre de Chile (CODELCO) (Government, 100%)	Mines Of which:	1,516,000.
			Andina	258,000.
			Chuquicamata	630,000.
			El Teniente	356,000.
			Rodomino Tomic	191,000.
			Salvador	81,000.
Do.		do.	Smelters Of which:	960,000.
			Chuquicamata	460,000.
			El Teniente	360,000.
			Salvador	140,000.
Do.		do.	Refineries Of which:	815,000.
			Chuquicamata (oxide)	600,000.
			Chuquicamata (sulfide)	85,000.
			Salvador	130,000.
Do.		do.	SX-EW ¹ plants Of which:	197,000.
			Chuquicamata (oxide)	130,000.
			El Teniente	2,000.
			Salvador (oxide 41 and sulfide 24)	65,000.
Do.		do.	Sulfuric acid plants Of which:	860,000.
			Chuquicamata (3 plants)	830,000.
			El Teniente	30,000.
Do.		Sociedad Contractual Minera El Abra, 51%, and Corporación Nacional del Cobre de Chile, 49%	El Abra mine	200,000.
Do.		Empresa Minera Mantos Blancos S.A. (Anglo- American Corp., 88%, and International Finance Corp., 12%)	Open pit, flotation/SX-EW ¹ plant, Mantos Blancos	80,000.
Do.		do.	Open pit, SX-EW ¹ plant, Mantoverde	42,000.
Copper, gold, silver	kilograms	Minera Escondida Ltda. (BHP Escondida Inc., 57.5%; Rio Tinto Escondida Ltd., 30%; Japan Escondida Corp., 10%; International Finance Corp., 2.5%)	Escondida open pit, copper mine, and plant Antofagasta, Region II	800,000 copper; 3,300 gold.
Do.		Empresa Nacional de Minería (ENAMI) (Government, 100%)	Taltal, Salado, Matta, Vallenor, Chancado plants	270,000 copper.
Do.		do.	Smelters Of which:	225,000 copper.
			Las Ventanas	145,000.
			Paipote	80,000.
Do.		do.	Las Ventanas refinery	200,000 copper.
Do.		do.	Chancado, Vallenar SX-EW ¹ plants	20,000 copper.
Do.	kilograms	Cía. Contractual Minera Candelaria (Phelps Dodge 80%; Sumitomo Metal Mining Co. Ltd., 15%; Sumitomo Corp., 5%)	Copiapó open pit mine and concentration plant, Region III	137,000 copper; 2,500 gold; 30,000 silver.

See footnotes at end of table.

TABLE 2--Continued
CHILE: STRUCTURE OF THE MINERAL INDUSTRY IN 2002

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Copper, gold, silver--Continued	kilograms	Cía. Contractual Minera Candelaria (Phelps Dodge, 80%; Sumitomo Metal Mining Co. Ltd., 15%; Sumitomo Corp., 5%)	Mine, 22 kilometers southeast of Copiapó and 9 kilometers south of Tierra Amrilla	2,488 gold.
Do.		Cía. Minera Disputada de Las Condes S.A. (Exxon Mobil Corp., 100%)	Mines: Of which: El Cobre El Soldado Las Bronces	148,000 copper. 18,000. 60,000. 70,000.
Do.		do.	Chagres smelter	75,000 copper.
Do.		do.	Chagres sulfuric acid plant	100,000 copper.
Do.		do.	Tortolas SX-EW ¹ plant	300,000 copper.
Do.	kilograms	Cía. Minera El Indio (Barrick Chile Ltda., 82.9%) (closed in mid-2002)	El Indio mine and concentration plant, Tambo, Pascua (Nevada), Region IV	NA.
Do.	do. do.	Cerro Bayo Ltda. (Coeur d' Alene Mines Corp., 100%)	Cerro Bayo Mine and concentration plant, Laguna Verde, Region XI	1,400 gold; 96,800 silver.
Do.	do. do. do.	Corporación Nacional del Cobre de Chile (Government, 100%) (gold and silver byproducts from copper)	Andina, Chuquicamata, El Salvador, and El Teniente	1,227 copper; 1,300 gold; 248 silver.
Do.	do.	Cía. Minera El Bronce de Petorca (private, 100%) (closed in 2001 and sold to Callejas family in 2002)	Carmencita 240, Providencia, Santiago	NA.
Do.	do. do.	Cía. Minera Mantos de Oro (Placer Dome Inc., 50%; TVX Gold Inc., 50%)	Ladera-Farellón, Brecha Norte, Coipa Norte La Coipa open pit mine, Region III	144,600 gold; 358,000 silver.
Iodine		Sociedad Química y Minera de Chile S.A. (private, 100%)	Miraflores 222, Santiago; Maria Elena, Pedro de Valdivia	7,150.
Iron ore		Cía. Minera del Pacifico S.A. (subsidiary of CAP S.A., formerly Cía de Acero del Pacifico S.A.) (private, 100%)	Mines: El Algarrobo, Region III, and El Romerol, La Serena Province, Region IV Pedro Pablo Muñoz 675, La Serena Province	5,200,000
Do.		Cía. Minera Huasco S.A. (Cía. Minera del Pacifico S.A., 50%; MC Inversiones Ltda., 50%)	Vallenar, Region III	2,100,000.
Iron ore pellets		do.	Huasco Pellet Plant, Region III	4,500,000
Lead and zinc	kilograms	Soc. Contractual Minera El Toqui Ltda. (Breakwater Resources Ltd. of Canada)	Baquedeno 238, Coyahaique, Region XI; Doña Rosa	470 gold; 500,000 zinc.
Lithium carbonate		Soc. Chilena de Litio Ltda. (subsidiary of Cyprus/ Amax Minerals Co. of the United States (private, 100%)	Salar de Atacama, Region II	20,000.
Do.		Soc. Minera Salar de Atacama (Minsal S.A.)	Toconao, Atacama	4,200.
Manganese		Manganesos Atacama S.A. (subsidiary of CAP S.A., 98.7%; with other private, 1.3%)	Coquimbo, Region IV	15,000.
Molybdenum		Corporación Nacional del Cobre de Chile (Government, 100%) (byproduct from copper)	Huérfanos 1270, Santiago	25,000.
Natural gas	million cubic feet	Empresa Nacional del Petróleo S.A. (subsidiary of Corporación de Fomento de la Producción) (Government, 100%)	Ahmuda 341, Santiago	4.
Petroleum	thousand barrels	do.	do.	6,500.
Potassium nitrate		do.	Planta Maria Elena, Iquique Province	250,000.
Do.		SQM Nitratos S.A. (subsidiary of Sociedad Química y Minera de Chile S.A.) (private, 100%)	Salar de Atacama, Antofagasta, Region II	560,000.
Do.		PCS Yumbes S.C.M. (subsidiary of Potash Corp. of Saskatchewan, Inc.) (private, 100%)	Salar de Atacama, Region II	100,000. ^c
Silver	kilograms	Corporación Nacional del Cobre de Chile (Government, 100%)	Huérfanos 1270, Santiago	604,100.
Sodium nitrate		SQM Nitratos S.A. (subsidiary of Sociedad Química y Minera de Chile S.A.) (private, 100%)	Mines: Maria Elena, Pampa Blanca, and Pedro de Valdivia	60,000.
Steel		Cía. Siderúrgica Huachipato S.A. (subsidiary of CAP S.A.) (private, 100%)	Huérfanos 669, Santiago	800,000.

^cEstimated; estimated data are rounded to no more than three significant digits. NA Not available.

¹Solvent-extraction/electrowinning.

TABLE 3
CHILE: ESTIMATED MAJOR MINERAL INVESTMENTS FROM 1994 THROUGH 2001¹

(Million dollars)

Region	Project	Commodity	Owner(s)	Investment	Startup date
I	Quebrada Blanca (expansion)	Copper cathodes	Aur Resources Inc. (76.5%); Soc. Minera Pudaheul Ltda. (13.5%); Empresa Nacional de Minería (10%)	373	1998
I	Collahuasi	do.	Falconbridge Ltd. (44%); Anglo American Plc. (44%); Mitsui Consortium (12%)	2,185	1998
II	Cerro Colorado	do.	BHP Billiton Plc.	200	1998
II	Alliance Copper Ltd.	do.	Corporación Nacional del Cobre de Chile (50%) and BHP Billiton Ltd. (50%)	60	2002
II	El Abra (Sociedad Contractual Minera El Abra)	do. (200,000 t/yr)	Cyprus El Abra Corp. (51%) and Corporación Nacional del Cobre de Chile (49%)	1,050	1997
II	Zaldívar	do.	Placer Dome Inc.	600	1995
II	Santa Barbara (expansion)	do.	Mantos Blancos S.A. (51%) and Anglo American Plc. (49%)	160	1996
II	Lomas Bayas	do.	Falconbridge Ltd.	244	1998
II	Escondida (expansion)	Copper oxides	BHP Billiton Ltd. (57.5%); Rio Tinto Plc. (30%); JECO Corp. (10%); International Finance Corp. (2.5%)	2,342	1998
II	Spence	Copper oxides	BHP Billiton Plc.	1,750	2000-04
II	Yolanda	Iodine, Nitrates (Na, K)	Kap Resources Ltd.	140	1998
II	Minsal	Lithium	Sociedad Química y Minera de Chile S.A.	290	1994
II	Ivan-Zar	do.	Rayrock Yellowknife Resources Inc.	36	1996
II	Fundición La Negra	do.	American Barrick Resources Corp. and Noranda Inc.	48	1997
II	Fundición Altonorte (expansion)	Blister copper	Noranda Inc.	170	2003
II	La Negra	do.	do.	158	2000
II	Cerro Negro Deposit	Copper	Atna Resources Ltd.	NA	NA
II	La Candelaria	Copper/Gold/Silver	Phelps Dodge Corp. (80%) and Sumitomo Metal Mining (15%)	1,500	1994
II	Sierra Gorda	Copper	Yuma Gold Mines Ltd.	85	NA
II	Prucobre	do.	Punta del Cobre S.A.	50	2000
II	Aguas Blancas	Copper cathodes	Atacama Minerals	27	NA
II	Santa Catalina	do.	Minera Santa Catalina S.A. and Outokumpu Oyj	100	NA
III	Agua de la Falda S.A.	Gold (bioleach)	Corporación Nacional del Cobre de Chile (49%) and Homestake Mining Co. (51%)	15	1999
III	La Candelaria	Copper/Gold/Silver	Phelps Dodge Corp. (80%) and Sumitomo Corp. (20%);	1,500	1994
III	Manto Verde	do.	Anglo American Corp. and Minorco Ltd.	180	1995
III	El Refugio	do.	Amex Gold Refugio Inc. and Bema Gold Corp.	130	1996
III	La Coipa	Gold/Silver	Placer Dome Inc. and TVX Gold Inc. (Cia. Minera Mantos de Oro S.A.)	400	1994
III	Nevada	Gold	Cia. Minera San José Inc. (American Barrick Resources Corp.)	168	1997
III	Aldebarán	do.	Placer Dome Inc.	800	1997
III	Chimberos	Silver	Placer Dome Inc. and TVX Gold Inc.	30	1998
III	Pascua-Lama	Gold/Silver	Barrick Gold Corp.	950	2008
III	Cerro Casale project	Copper/Gold	Placer Dome Ltd. (51%); Arizona Star Resource Corp. (25%); Bema Gold Corp. (24%)	1,330	NA
III	Lobo Marte	Gold	Teck Cominco Ltd. (60%) and Anglo American Corp. (40%)	300	NA
III	Los Colorados	Iron ore	Cia. Minera del Pacifico S.A. (50%) and MC Inversiones Ltda. (Mitsubishi Corp.) (50%)	100	1998
III	Radomiro Tomic	Copper	Division Radomiro Tomic (Corporación Nacional del Cobre de Chile)	279	2001
III	Atacama Kozan	do.	Inversiones Errazuriz Ltda. and Nittetsu Mining Co., Ltd.	136	2002-03
IV	Los Pelambres (expansion)	do.	Antofagasta Plc. (60%); Nippon Mining and Metals Co., Ltd. (15%); Mitsubishi Materials Corp. (10%); Marubeni Corp. (8.75%); Mitsubishi Corp. (5%); Mitsui & Co., Ltd. (1.25%)	1,307	2001
IV	Tesoro	do.	Antofagasta Plc. (61%) and Equatorial Mining Ltd. (31%)	300	2001
IV	Tambo (expansion)	Gold	Cia. Minera San José Inc. (American Barrick Resources Corp.)	105	1995
IV	Andacollo Cobre	Copper	Aur Resources Inc. (63%); Cia. Minera del Pacifico S.A. (27%); Empresa Nacional de Minería (10%)	55	1997
XI	Alumysa	Aluminum	Noranda Inc.	2,750	2004
XI	Cerro Bayo	Gold/Silver	Coeur d'Alene Mines Corp.	85	2004

NA Not available.

¹Estimated data are rounded to no more than three significant digits.